

**§ 98.83 Calculating GHG emissions.**

You must calculate and report the annual process CO<sub>2</sub> emissions from each kiln using the procedure in paragraphs (a) and (b) of this section.

(a) For each cement kiln that meets the conditions specified in § 98.33(b)(4)(ii) or (b)(4)(iii), you must calculate and report under this subpart the combined process and combustion CO<sub>2</sub> emissions by operating and maintaining a CEMS to measure CO<sub>2</sub> emissions according to the Tier 4 Calculation Methodology specified in § 98.33(a)(4) and all associated requirements for Tier 4 in subpart C of this part (General Stationary Fuel Combustion Sources).

(b) For each kiln that is not subject to the requirements in paragraph (a) of this section, calculate and report the

process and combustion CO<sub>2</sub> emissions from the kiln by using the procedure in either paragraph (c) or (d) of this section.

(c) Calculate and report under this subpart the combined process and combustion CO<sub>2</sub> emissions by operating and maintaining a CEMS to measure CO<sub>2</sub> emissions according to the Tier 4 Calculation Methodology specified in § 98.33(a)(4) and all associated requirements for Tier 4 in subpart C of this part (General Stationary Fuel Combustion Sources).

(d) Calculate and report process and combustion CO<sub>2</sub> emissions separately using the procedures specified in paragraphs (d)(1) through (d)(4) of this section.

(1) Calculate CO<sub>2</sub> process emissions from all kilns at the facility using Equation H-1 of this section:

$$CO_{2CMF} = \sum_{m=1}^k CO_{2Cli,m} + CO_{2rm} \quad (\text{Eq. H-1})$$

Where:

CO<sub>2CMF</sub> = Annual process emissions of CO<sub>2</sub> from cement manufacturing, metric tons.

CO<sub>2Cli,m</sub> = Total annual emissions of CO<sub>2</sub> from clinker production from kiln m, metric tons.

CO<sub>2rm</sub> = Total annual emissions of CO<sub>2</sub> from raw materials, metric tons.

k = Total number of kilns at a cement manufacturing facility.

(2) *CO<sub>2</sub> emissions from clinker production.* Calculate CO<sub>2</sub> emissions from each kiln using Equations H-2 through H-5 of this section.

$$CO_{2Cli,m} = \sum_{j=1}^p \left[ (Cli_{j,j}) * (EF_{Cli,j}) * \frac{2000}{2205} \right] + \sum_{i=1}^r \left[ (CKD_{i,i}) * (EF_{CKD,i}) * \frac{2000}{2205} \right] \quad (\text{Eq. H-2})$$

Where:

Cli<sub>j</sub> = Quantity of clinker produced in month j from kiln m, tons.

EF<sub>Cli,j</sub> = Kiln specific clinker emission factor for month j for kiln m, metric tons CO<sub>2</sub>/metric ton clinker computed as specified in Equation H-3 of this section.

CKD<sub>i</sub> = Cement kiln dust (CKD) not recycled to the kiln in quarter i from kiln m, tons.

EF<sub>CKD,i</sub> = Kiln specific CKD emission factor for quarter i from kiln m, metric tons

CO<sub>2</sub>/metric ton CKD computed as specified in Equation H-4 of this section.

p = Number of months for clinker calculation, 12.

r = Number of quarters for CKD calculation, 4.

2000/2205 = Conversion factor to convert tons to metric tons.

(i) *Kiln-Specific Clinker Emission Factor.* (A) Calculate the kiln-specific clinker emission factor using Equation H-3 of this section.

$$EF_{\text{Cli}} = (Cli_{\text{CaO}} - Cli_{\text{ncCaO}}) * MR_{\text{CaO}} + (Cli_{\text{MgO}} - Cli_{\text{ncMgO}}) * MR_{\text{MgO}} \quad (\text{Eq. H-3})$$

Where:

$Cli_{\text{CaO}}$  = Monthly total CaO content of Clinker, wt-fraction.

$Cli_{\text{ncCaO}}$  = Monthly non-calcined CaO content of Clinker, wt-fraction.

$MR_{\text{CaO}}$  = Molecular-weight Ratio of  $\text{CO}_2/\text{CaO}$  = 0.785.

$Cli_{\text{MgO}}$  = Monthly total MgO content of Clinker, wt-fraction.

$Cli_{\text{ncMgO}}$  = Monthly non-calcined MgO content of Clinker, wt-fraction.

$MR_{\text{MgO}}$  = Molecular-weight Ratio of  $\text{CO}_2/\text{MgO}$  = 1.092.

(B) Non-calcined CaO is CaO that remains in the clinker in the form of

$\text{CaCO}_3$  and CaO in the clinker that entered the kiln as a non-carbonate species. Non-calcined MgO is MgO that remains in the clinker in the form of  $\text{MgCO}_3$  and MgO in the clinker that entered the kiln as a non-carbonate species.

(ii) *Kiln-Specific CKD Emission Factor.*

(A) Calculate the kiln-specific CKD emission factor for CKD not recycled to the kiln using Equation H-4 of this section.

$$EF_{\text{CKD}} = (CKD_{\text{CaO}} - CKD_{\text{ncCaO}}) * MR_{\text{CaO}} + (CKD_{\text{MgO}} - CKD_{\text{ncMgO}}) * MR_{\text{MgO}} \quad (\text{Eq. H-4})$$

Where:

$CKD_{\text{CaO}}$  = Quarterly total CaO content of CKD not recycled to the kiln, wt-fraction.

$CKD_{\text{ncCaO}}$  = Quarterly non-calcined CaO content of CKD not recycled to the kiln, wt-fraction.

$MR_{\text{CaO}}$  = Molecular-weight Ratio of  $\text{CO}_2/\text{CaO}$  = 0.785.

$CKD_{\text{MgO}}$  = Quarterly total MgO content of CKD not recycled to the kiln, wt-fraction.

$CKD_{\text{ncMgO}}$  = Quarterly non-calcined MgO content of CKD not recycled to the kiln, wt-fraction.

$MR_{\text{MgO}}$  = Molecular-weight Ratio of  $\text{CO}_2/\text{MgO}$  = 1.092.

(B) Non-calcined CaO is CaO that remains in the CKD in the form of  $\text{CaCO}_3$  and CaO in the CKD that entered the kiln as a non-carbonate species. Non-calcined MgO is MgO that remains in the CKD in the form of  $\text{MgCO}_3$  and MgO in the CKD that entered the kiln as a non-carbonate species.

(3) *CO<sub>2</sub> emissions from raw materials.* Calculate  $\text{CO}_2$  emissions from raw materials using Equation H-5 of this section:

$$CO_{2,rm} = \sum_{i=1}^m rm_i * TOC_{rm_i} * \frac{44}{12} * \frac{2000}{2205} \quad (\text{Eq. H-5})$$

Where:

$rm$  = The amount of raw material  $i$  consumed annually, tons/yr (dry basis) or the amount of raw kiln feed consumed annually, tons/yr (dry basis).

$CO_{2,rm}$  = Annual  $\text{CO}_2$  emissions from raw materials.

$TOC_{rm}$  = Organic carbon content of raw material  $i$  or organic carbon content of combined raw kiln feed (dry basis), as determined in § 98.84(c) or using a default fac-

tor of 0.2 percent of total raw material weight.

$M$  = Number of raw materials or 1 if calculating emissions based on combined raw kiln feed.

$44/12$  = Ratio of molecular weights,  $\text{CO}_2$  to carbon.

$2000/2205$  = Conversion factor to convert tons to metric tons.

(4) Calculate and report under subpart C of this part (General Stationary

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Fuel Combustion Sources) the combustion CO<sub>2</sub> emissions from the kiln according to the applicable requirements in subpart C.

[74 FR 56374, Oct. 30, 2009, as amended at 75 FR 66461, Oct. 28, 2010]

### § 98.84 Monitoring and QA/QC requirements.

(a) You must determine the weight fraction of total CaO and total MgO in CKD not recycled to the kiln from each kiln using ASTM C114-09, Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see § 98.7). The monitoring must be conducted quarterly for each kiln from a CKD sample drawn either as CKD is exiting the kiln or from bulk CKD storage.

(b) You must determine the weight fraction of total CaO and total MgO in clinker from each kiln using ASTM C114-09 Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see § 98.7). The monitoring must be conducted monthly for each kiln from a monthly clinker sample drawn from bulk clinker storage if storage is dedicated to the specific kiln, or from a monthly arithmetic average of daily clinker samples drawn from the clinker conveying systems exiting each kiln.

(c) The total organic carbon content (dry basis) of raw materials must be determined annually using ASTM C114-09 Standard Test Methods for Chemical Analysis of Hydraulic Cement (incorporated by reference, see § 98.7) or a similar industry standard practice or method approved for total organic carbon determination in raw mineral materials. The analysis must be conducted either on sample material drawn from bulk raw kiln feed storage or on sample material drawn from bulk raw material storage for each category of raw material (i.e., limestone, sand, shale, iron oxide, and alumina). Facilities that opt to use the default total organic carbon factor provided in § 98.83(d)(3), are not required to monitor for TOC.

(d) The quantity of clinker produced monthly by each kiln must be determined by direct weight measurement of clinker using the same plant techniques used for accounting purposes,

such as reconciling weigh hopper or belt weigh feeder measurements against inventory measurements. As an alternative, facilities may also determine clinker production by direct measurement of raw kiln feed and application of a kiln-specific feed-to-clinker factor. Facilities that opt to use a feed-to-clinker factor must verify the accuracy of this factor on a monthly basis.

(e) The quantity of CKD not recycled to the kiln generated by each kiln must be determined quarterly using the same plant techniques used for accounting purposes, such as direct weight measurement using weigh hoppers, truck weigh scales, or belt weigh feeders.

(f) The annual quantity of raw kiln feed or annual quantity of each category of raw materials consumed by the facility (e.g., limestone, sand, shale, iron oxide, and alumina) must be determined monthly by direct weight measurement using the same plant instruments used for accounting purposes, such as weigh hoppers, truck weigh scales, or belt weigh feeders.

(g) The monthly non-calcined CaO and MgO that remains in the clinker in the form of CaCO<sub>3</sub> or that enters the kiln as a non-carbonate species may be assumed to be a default value of 0.0 or may be determined monthly by careful chemical analysis of feed material and clinker material from each kiln using well documented analytical and calculational methods or the appropriate industry standard practice.

(h) The quarterly non-calcined CaO and MgO that remains in the CKD in the form of CaCO<sub>3</sub> or that enters the kiln as a non-carbonate species may be assumed to be a default value of 0.0 or may be determined quarterly by careful chemical analysis of feed material and CKD material from each kiln using well documented analytical and calculational methods or the appropriate industry standard practice.

[74 FR 56374, Oct. 30, 2009, as amended at 75 FR 66461, Oct. 28, 2010]

### § 98.85 Procedures for estimating missing data.

A complete record of all measured parameters used in the GHG emissions calculations in § 98.83 is required.